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CONTROL OF HOUSE FLIES IN BARNS WITH DIFFERENT INSECTICIDES[1] [2]

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In 1948 serious fly problems developed in many sections of the United States and in several foreign countries from the failure of DDT residues to control house flies (Musca domestica L.) in places where they had formerly been highly effective. Experiments at the Orlando, Fla., laboratory indicate that the failures were due largely to an increased resistance of flies to DDT (King and Gahan 4). Flies collected from different dairy barns showed some differences in resistance, but it was very marked in some locations. The DDT-resistant flies proved to be somewhat more susceptible to methoxychlor and much more so to chlordane or benzene hexachloride, an indication that these insecticides might be substituted successfully for DDT. Since this study was begun, several workers have reported the results of field tests with these materials (Bettini and Barachini 1, March and Metcalf 6, Bruce 2, Keiding and Van Deurs 3, and Mosna 7).

In the fall of 1948 tests were made at Orlando to compare the effectiveness of DDT, chlordane, and methoxychlor for fly control in dairy barns where DDT had proved ineffective. In these tests DDT was ineffective after the first week, whereas chlordane and methoxychlor showed

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a high degree of control for 11 weeks or longer. This prolonged period of control may have been due in part to the seasonal decline in fly breeding, as indicated by a substantial reduction in fly populations in check barns.

Early in February 1949 tests with DDT and other insecticides as residual treatments were started in dairy barns in southern Florida (Miami area), where large fly populations were already present. It was hoped by these tests to select a material in advance of the general fly-breeding season which could be recommended for house fly control in places where DDT was no longer effective. A second series of tests in the same locality was begun early in April and continued until June. A preliminary report on these studies has been presented by Knipling (5). Additional tests in central Florida (Orlando area) were initiated early in May and continued throughout the summer and early fall. Flies collected from most of the dairies were also tested in the laboratory to determine their susceptibility to DDT or methoxychlor, or both, and to the insecticides with which the different barns were to be treated. Preliminary tests were also made at Orlando to evaluate the effectiveness of frequent space spraying in open-type dairy barns for the control of house flies. The results of these investigations are presented in this paper.

Tests of Residual Treatments in Dairy Barns

Dairy barns were selected where flies were abundant and in most cases where DDT or methoxychlor had been used for some time, generally with unsatisfactory results. Two newly constructed barns were included. The sanitation on the dairy premises was generally poor, as most of the owners relied principally on residual treatments inside the barns to reduce breeding and adult populations. Each barn was visited at least twice before treatment to obtain an index of the fly population and to observe the breeding potential on the premises. Measurements were made of the surfaces to be treated to determine the amount of spray material required. Owners were requested to refrain from spraying either the animals or the premises until the tests were completed, but this request was sometimes disregarded, and thus it was difficult to evaluate the results.

DDT and methoxychlor were applied separately in emulsions and in wettable-powder suspensions, and in sprays made from a 1:1 mixture of wettable powders of both insecticides. Chlordane was tested as an emulsion alone and in a 2:3 mixture with DDT. Dieldrin was applied as an emulsion, and lindane, toxaphene, and pyrethrum extract (with piperonyl butoxide) in both types of formulations. In the first tests in the Miami area all the materials were applied as 5-percent sprays, the total amount being varied as needed to give the desired dosage. In the later tests at Miami and in all the tests at Orlando, the concentrations

were varied and the applications made at the uniform rate of 1 gallon per 1,000 square feet of surface. Sprays were applied at close range with a power sprayer operated at a pressure of 75 pounds per square inch. Before the sprays were applied, the feed troughs were covered and the barns were freed of cattle.

Fly counts were made at three locations in each dairy both 2 to 4 days before treatment and at various intervals thereafter. A piece of 1/4-inch mesh hardware cloth, 6 by 12 inches, was laid over two 5 1/2-inch petri dishes containing equal parts of malt extract and water as an attractant, and counts were made of flies alighting on the screen in 30 seconds. Averages were taken of 5 to 10 counts at each location, the flies being disturbed after each count.

The results of these tests are presented in table 1. In the Miami area (M) chlordane emulsion at 200 mg. per square foot gave excellent control in one barn (M-6) for 5 weeks and a 100-mg. dosage showed good results in another barn (M-14) for at least 7 weeks. In the Orlando area (O) this material at 100 mg. per square foot was the most effective of all those tested, averaging 90-percent reduction for five treatments after 6-7 weeks. Three of these barns showed 92 to 100 percent reduction after 8-9 weeks, and one of them 97 percent after 10-11 weeks.

At Miami an emulsion containing DDT and chlordane gave poorer control than chlordane alone, but considerably better than a concurrent test with DDT alone.

Lindane wettable-powder sprays at 50 mg. of toxicant per square foot gave excellent control in one barn (O-23) for 6 weeks, and good control for 2 additional weeks. After a second treatment at the same dosage 90-percent reduction was obtained for 9 weeks. In the Miami area dosages of 25 and 50 mg. of lindane, although giving somewhat variable results, appeared to be about equally effective. Both dosages gave over 90-percent reduction for only 3 weeks in February and 2 weeks in April. In the Orlando area 25 mg. per square foot was less effective than 50 mg., and in only one barn (O-27) was control greater than 88 percent after the first week. Three tests late in the season with a 10-mg. dosage showed excellent control for 2 to 3 weeks.

Dieldrin at 50 mg. per square foot in emulsion form gave excellent control for 6 weeks or more in four barns, and a re-treatment of one barn gave almost complete effectiveness for 10-11 weeks. In two treatments each, 25- and 10-mg. dosages appeared to give about as good results as the 50-mg. dosage.

Toxaphene emulsion applied to a previously untreated dairy barn at 200 mg. of toxicant per square foot gave excellent control for 8 weeks, and a re-treatment at the same dosage showed similar results. However, in a frequently treated barn two treatments with a wettable-powder spray at the same dosage gave very unsatisfactory results. In another barn two treatments at 100 mg. were ineffective, but a third treatment at

Table 1.--Reduction of house flies in dairy barns after residual treatments with various insecticides applied as emulsion (E) or wettable-powder (WP) sprays, 1949

Barn No.	Date treated	Formulation and dosage of toxicant (mg. / sq. ft.)	Pretreatment counts	Percent reduction at indicated time (weeks) after treatment								
				1	2	3	4	5	6	7	8-9	10-11
				Chlordane								
M-6	Feb. 10	200 E	111	99	100	99	95	94	67	Resprayed by owner		
M-14	Apr. 7	100 E	228	99	89	96	86	93	89	98		
O-24	May 9	100 E	124	92	93	91	91	84	90	75	56	
	June 29	100 E	43	74	99	97	98	98	94	84	100	87
O-25	May 9	100 E	275	99	98	98	97	96	94	93	82	
	June 29	100 E	34	84	96	95	97	99	85	94	92	88
O-31	June 27	100 E	83	90	97	99	92	97	92	100	98	97
				Dieldrin								
M-9	Feb. 18	50 E	80	81	85	Resprayed by owner.						
M-16	Apr. 4	50 E	194	98	95	99	99	94	98	97		
O-30	June 14	50 E	58	95	81	98	100	95	97	39		
	Aug. 5	50 E	36	100	100	100	100	100	100	99	100	100
O-29	June 2	250 E 1/	177	93	91	73	71					
	July 5	50 E	53	70	84	91	93	94	77	92	68	
	Sept. 1	50 E	27	56	81	88	100	100	100			
O-34	July 7	25 E	74	80	70	98	95	91	45	86	65	67
O-35	July 26	25 E	92	99	98	98	100	100	99	100	98	
O-37	Aug. 16	10 E	82	100	100	100	100	99	100	100	100	
O-34	Sept. 23	10 E	60	97	95	96						

Table 1.--(Continued)

Barn No.	Date treated	Formulation and dosage of toxicant (mg./ sq. ft.)	Pretreatment counts	Percent reduction at indicated time (weeks) after treatment								
				1	2	3	4	5	6	7	8-9	10-11
				Lindane								
M-7	Feb. 10	50 WP	440	99	99	96	90	86	67			
	Apr. 4	50 WP	172	92	89	1	Resprayed by owner.					
O-23	May 12	50 WP	250	99	95	98	97	95	95	86	70	
	July 18	50 WP	118	99	99	99	92	100	97	90	90	73
M-8	Feb. 20	25 WP	171	98	91	95	68	66	59			
M-15	Apr. 7	25 WP	226	99	94	84	77	78	57	26		
O-27	July 6	25 WP	73	84	29							
	July 25	25 WP	79	99	96	98	91	95	77	78	93	84
O-33	June 30	25 WP	121	94	80	21						
	July 26	25 WP	80	96	88	85	53	52				
	Aug. 31	25 WP	41	98	62	76	14	0	0			
O-36	July 21	25 E	166	95	81	88	92	81	89	88	49	84
O-38	Aug. 17	10 E	105	100	99	92	50					
O-39	Aug. 18	10 WP	64	99	100	Discontinued (resprayed by owner).						
O-40	Sept. 19	10 WP	49	100	96	76						
				DDT								
M-5	Feb. 18	200 WP	49	38	16	7	10					
O-21 [2/]	May 5	200 WP	88	93	10	0	Re-treated with DDT-methoxychlor.					
M-13	Apr. 6	200 E	186	96	97	91	89	91	86	69		
				DDT-chlordane								
M-10	Feb. 14	120 + 80 E	102	87	91	95	89	81	79			

Table 1. --(Continued)

Barn No.	Date treated	Formulation and dosage of toxicant (mg. / sq. ft.)	Pretreatment counts	Percent reduction at indicated time (weeks) after treatment								
				1	2	3	4	5	6	7	8-9	10-11
				Methoxychlor								
M-12	Feb. 15	200 E	196	75	83	Painted						
M-20	Apr. 6	200 WP	358	99	87	88	85	81	66	32		
O-26	May 11	200 WP	31	92	83	77	0	36				
O-27	May 16	200 WP	279	84	83	72						
	June 7	200 WP	84	51	0	Re-treated with DDT-methoxychlor						
				DDT-methoxychlor								
M-17	Apr. 6	100 + 100 WP	414	99	98	90	93	93	88	84		
O-21	May 23	100 + 100 WP	164	97	99	93	85	93	91	96	83	97
O-22	June 2	100 + 100 WP	80	98	63	Re-treated with toxaphene.						
O-27	June 23	100 + 100 WP	83	52	0	Re-treated with lindane.						
				Toxaphene								
O-28 [2/]	May 23	200 E	181	97	96	99	95	100	99	97	87	
	July 27	200 E	49	90	99	99	100	100	99	81	54	36
O-22	June 20	200 WP	67	93	99	94	92	67	39	59		
	July 14	200 WP	68	77	28	88	95	93	21	100	69	
O-32	June 28	100 WP	164	95	89	88						
	July 22	100 WP	81	60	27							
	Aug. 9	200 WP	49	83	99	100	96	53				

Table 1. --(Continued)

Barn No.	Date treated	Formulation and dosage of toxicant (mg./sq. ft.)	Pretreatment counts	Percent reduction at indicated time (weeks) after treatment								
				1	2	3	4	5	6	7	8-9	10-11
Pyrethrins plus piperonyl butoxide												
M-19	Apr. 8	10 + 100 E	262	90	96	Resprayed by owner.						
O-29	May 26	10 + 100 WP	239	43	Re-treated with dieldrin.							
M-11	Feb. 16	5 + 50 E	220	60	25	Resprayed by owner.						
M-18	Apr. 5	5 + 50 WP	197	59	29	20						

1/ This emulsion broke badly and an undetermined amount was left as a gummy residue in the sprayer.

2/ Newly constructed barn.

200 mg. was effective for 4 weeks. Further tests are needed to determine whether the emulsion is more effective than the wettable-powder spray.

In the Miami area DDT was almost a complete failure in one test (M-5), but in another test (M-13) it showed a high reduction of flies for 6 weeks. In the Orlando area DDT wettable powder in a newly constructed barn (O-21) was ineffective after the first week. After re-treatment of this barn with a mixture of DDT and methoxychlor, fly counts were low for 10-11 weeks. Similar treatments with DDT-methoxychlor mixture showed good control for 7 weeks in one barn but were ineffective in two others. Methoxychlor gave 99 percent control for 1 week and 85-88 percent control for 4 more weeks in one barn, while in three others only fair (72-83 percent) control for the first 2 weeks was obtained. A second treatment of one of the barns was almost a complete failure.

Two treatments with 5 mg. of pyrethrins plus 50 mg. of piperonyl butoxide, one in an emulsion and the other in a wettable-powder spray, were noneffective after 2 days. Fair control of flies was obtained for 1 week in one barn (M-19) treated with 10 mg. of pyrethrins plus 100 mg. of piperonyl butoxide. In the second week the fly counts dropped to 4 percent of the original number, and it was learned later that the owner had been spraying the cows and applying space sprays in the barn. A 10-mg. treatment in another barn (O-29) was a complete failure.

Lindane and methoxychlor residual treatments and pyrethrum and organic thiocyanate space sprays are recommended by the U. S. Department of Agriculture for use in dairy barns. DDT, toxaphene, chlordane, and dieldrin are not recommended at present because of the possible danger of milk contamination.

Laboratory Tests of Residual Treatments

For most of the laboratory tests flies collected in the dairy barns before treatment were used, but sometimes the populations were low and laboratory rearings from collected flies were necessary to obtain sufficient numbers for testing. Flies were exposed for various periods under petri dishes on plywood panels treated with DDT, methoxychlor, and toxaphene at 25 mg. per square foot, and dieldrin and lindane at 10 mg. The exposure times required to cause 70-percent mortality (LT-70), as computed from these records, provide some information as to the relative susceptibility of the flies in different locations. It was thought that this might be of value in interpreting variations in results shown by different treatments.

The results with flies from different dairy barns and from the laboratory colony are summarized in table 2. The results with DDT were similar to those obtained in 1948. The exposure period necessary to kill 70 percent of the dairy flies was 10 times that for the laboratory colony.

With methoxychlor the exposures for dairy flies were 2 to 3 times as long, and with toxaphene, lindane, and dieldrin less than twice as long as for the laboratory colony. Dieldrin was the outstanding material. None of the flies from the chlordane-treated barns were tested in the laboratory.

Table 2. --Toxicity of various insecticides to female flies from dairy barns and from the laboratory colony

Insecticide	Dosage of toxicant (mg./sq. ft.)	Number of barns	LT-70 (minutes)		
			Dairy flies		Laboratory colony, average
			Range	Average	
DDT wettable powder	25	21	13-55	34.4	3.2
Methoxychlor wettable powder	25	9	3.4-21	12.2	5.4
Toxaphene wettable powder	25	2	28-65	47.0	28.0
Toxaphene emulsion	25	1	--	88.0	65.0
Lindane wettable powder	10	3	15-67	41.0	35.0
Lindane emulsion	10	1	--	17.0	15.0
Dieldrin emulsion	10	2	1-1.7	1.4	1.0

There seemed to be little correlation between the susceptibility of the flies and the effectiveness of the treatments. The most striking example of this lack of correlation occurred with the stock of flies from the barn (O-28) treated with toxaphene emulsion. The LT-70 for toxaphene was very high in comparison with those for DDT and methoxychlor, but the treatments with toxaphene in this barn were much more effective than any of the treatments in other locations with DDT and methoxychlor. No explanation can be offered for such discrepancy.

Tests with Space Sprays in Dairy Barns

Three insecticides were tested in dairy barns as space sprays. Lindane and dieldrin were applied as 2-percent emulsions, and pyrethrum as an emulsion containing 0.5 percent of pyrethrins plus 5 percent of piperonyl butoxide. These sprays were applied at the rate of 1 ml. to 10 square feet of floor space with a mist sprayer having a delivery rate of 20 ml. per minute. These dosages gave 2 mg. of lindane and dieldrin and 0.5 mg. of pyrethrins per square foot. Fly counts were made in the same way as in the tests of residual treatments.

Six sprayings with lindane resulted in only a 74-percent reduction the first week, and five sprayings the second week showed only 82-percent control. However, the control was 95 percent during the third week with four sprayings, 98 percent during the fourth week with two sprayings, and then dropped to 89 percent during the fifth week when only two sprayings were made.

With dieldrin an average control of 89 percent was obtained the first week with six sprayings, and this figure was maintained the second week with three applications. Almost no flies were in evidence early in the third week, but when treatments were omitted for 4 days, the flies returned in moderate numbers. After another treatment the numbers decreased again for several days.

Laboratory tests indicated that more than 50 percent of lindane and dieldrin applied as space sprays in the dairy barns was deposited on the floor and formed a light residue that was effective for a few hours after treatment.

In the tests with pyrethrum plus piperonyl butoxide four sprayings resulted in only 53-percent reduction of flies during the first week and 80 percent during the second week. This control was maintained the third week with three applications, and four applications the fourth week showed 93 percent reduction. The same degree of control was maintained in the fifth week with daily applications.

The results of these tests indicate that house flies in dairy barns may be controlled by frequent space sprayings. The full benefit of the treatments was not in evidence until the third week, but it appeared that after the general fly population was greatly reduced two or three sprayings per week would maintain a high degree of control.

Summary

Studies on the control of house flies (Musca domestica L.) in dairy barns with residual treatments of various insecticides were conducted in the vicinity of Miami and Orlando, Fla., during 1942. Tests were also made at Orlando to determine the effectiveness of several insecticides as space sprays in dairy barns. The resistance of flies from different dairy barns to these insecticides was determined in laboratory tests.

Chlordane emulsion at 100 mg. of toxicant per square foot was the most consistently effective treatment, showing 84 to 98-percent control for 5 to 7 weeks or longer in all barns. DDT failed to give appreciable control in two of three barns. A mixture of chlordane and DDT was less effective than chlordane alone but was more effective than DDT alone. Methoxychlor and a mixture of DDT and methoxychlor were effective in some cases, but not in others. A 50-mg. dosage of lindane gave [illegible] than a 25-mg. dosage. Dieldrin gave excellent control of flies for [illegible]

tests at dosages of 50, 25, and 10 mg. per square foot. Toxaphene at 200 mg. per square foot was highly effective as an emulsion, but was less effective in a wettable-powder spray.

Treatments with 5 mg. of pyrethrins plus 50 mg. of piperonyl butoxide were relatively ineffective, and twice this dosage gave only fair control for 1 week.

Preliminary tests indicated that good control of house flies in dairy barns can be obtained by frequent space spraying with lindane, dieldrin, or pyrethrum plus piperonyl butoxide. Almost daily spraying for 2 weeks appeared to be necessary to reduce the fly population, but thereafter two or three applications a week maintained a high degree of control.

Laboratory tests with flies from most of the dairy barns showed that all were resistant to DDT. The exposure time required to kill 70 percent of the female flies from dairy barns was 10 times that for the laboratory colony. With methoxychlor the exposures of dairy flies were 2 to 3 times, and with toxaphene, lindane, and dieldrin less than twice as long as for the laboratory colony. There appeared to be no particular correlation between degree of resistance to DDT and the degree of control obtained with other insecticides.

Literature Cited

(1) Bettini, S., and Barachini, B.
1948. Primi resultati della lotta con l'Octa-Klor ed il gammaesano contro le mosche domestiche resistenti al DDT. Riv. di Parassitol. 9(2): 85-91.

(2) Bruce, W. N.
1949. Latest report on fly control. Pests and Their Control 17(6): 7, 28.

(3) Keiding, J., and Van Deurs, H.
1949. D.D.T.-resistance in houseflies in Denmark. Nature 163: 964.

(4) King, W. V., and Gahan, J. B.
1949. Failure of DDT to control house flies. Jour. Econ. Ent. 42(3): 405-409.

(5) Knipling, E. F.
1949. DDT developments. Soap and Sanit. Chem. 25(7): 107-111.

(6) March, R. B., and Metcalf, R. L.
1949. Laboratory and field studies of DDT-resistant houseflies in southern California. Calif. Dept. Agr. Bul. 38(2): 1-8.

(7) Mosna, E.
1949. Octa-Klor, gammaesano e toxaphene usati contro le mosche DDT resistenti. Riv. di Parassitol. 10(1): 31-51.